# OFFICE AIR POLLUTION AND ITS HEALTH EFFECTS: A GROWING NEED FOR RESOLUTION BY MANAGERS



COMMONWEALTH OF MASSACHUSETTS
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# A GROWING NEED FOR RESOLUTION BY MANAGERS

Commonwealth of Massachusetts

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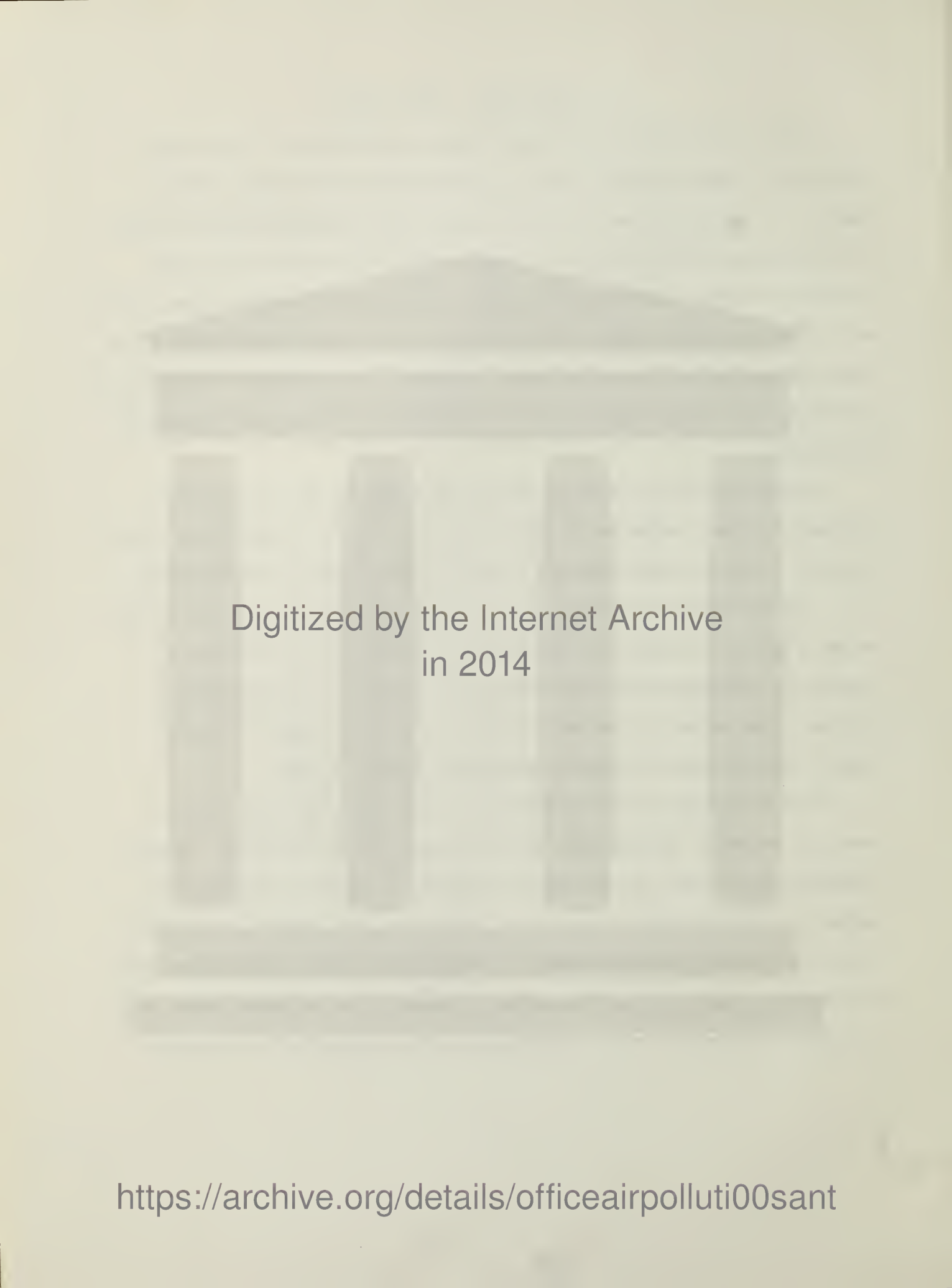
## 1) INTRODUCTION: THE PROBLEM

It has been traditionally assumed that 'air pollution' is an outdoor phenomenon in which buildings provide a sanctuary from its harmful effects. However, the growing number of health complaints and scientific health studies are increasingly revealing that the danger from air pollution is no longer confined to outdoor air, but that a greater health risk is lurking right inside our offices and homes. These studies reveal that air pollution indoors may be several times higher than outdoor air. The risk to human health is exacerbated by the fact that people spend over 90% of their time indoors, particularly in the winter.

Because of the energy crisis of the early 1970's, there has been an increasing national emphasis on energy conservation which is manifested in more airtight, super-insulated homes and buildings, particularly in the Northeast U.S. This has resulted in very tight buildings with very low ventilation which entrap a myriad of harmful air pollutants emanating from a wide array of sources and contributing to the "Sick Building Syndrome". These sources include a wide variety of synthetic materials, aerosol sprays, biological agents, tobacco smoke, building materials and outdoor sources.

Five of the major indoor pollutants include carbon dioxide, carbon monoxide, asbestos, formaldehyde, micro-organisms and hydrocarbons. Initial symptoms include eye, nose and throat irritations, fatigue, headaches and nausea. Long-term exposure may lead to kidney and liver damage, respiratory infections, cancer and birth defects. These health effects arising from homes and offices account for over 50% of all illnesses at an estimated annual cost of $100b including the cost of absenteeism and low productivity (Zielinsky).



This new found awareness about the harmful effects of indoor air pollution, has created a national dilemma over the last decade because there is no explicit federal or state statute to adequately address this burgeoning, complex problem. No federal agency is directly responsible for addressing indoor air pollution in homes and offices; hence, there is no established federal program. The EPA, under the Clean Air Act, is responsible for monitoring ambient air only, and the Occupational and Safety and Health Administration (OSHA) is responsible for air quality in the industrial workplace. This lack of a national policy on indoor air pollution in offices has resulted in several states adopting fragmented programs of their own based on a few pollutants (Budianksy). This has led to inconsistency of programs among the states.

There is, therefore, a growing need for public awareness of office air pollution and its health effects. It is, therefore, essential that office managers and building superintendents be made aware of this public health threat. Some form of training should be provided to managers for addressing the sources, health effects and remedial strategies to minimize the problem in the workplace.

## 2) SOURCES AND HEALTH EFFECTS OF OFFICE AIR POLLUTION

A comprehensive knowledge of the sources of office air pollution is of primary importance in understanding the magnitude of the potential health risks to the working population. Current research on the sources and health efects is still at the developmental stage, such that new sources are increasingly being added to the inventory and new health risks are, therefore, discovered with the passage of time.

There are two broad categories of office air pollutants: those generated outdoors which infiltrate indoors, and those generated indoors as a result of human activities, building materials, synthetic materials, and office machinery. Occupants generate airborne pollutants through food preparation (eg. coffee makers), tobacco smoking, cleaning products, paints, adhesives, furniture cleaning and they, themselves, may shed skin cells and hair. Other air pollutants emanate from carpeting, plywood, concrete, copying machines, video display terminals (VDT's), pesticides, and other biological agents.

Tobacco smoking is a major component of office air pollution. Over 30% of the U.S. smoke regularly and 'passive smokers' are involuntarily exposed to a wide range of pollutants including carbon monoxide, particulates, polycyclic organic matter, hydrocarbons, nicotene and arsenic. Smoke inhalation can lead to eye and throat irritations, headaches, coughing and wheezing. Chronic exposures may lead to bronchitis, emphysema and lung cancer. The Surgeon General, in 1982, estimated that about 85 percent of all lung cancer deaths were attributable to smoking and passive smoking. A British study revealed that non-smoking wives of smokers had significantly higher lung cancer rates than non-smoking wives of non-smokers (Repace and Lowrey). The presence of tobacco smoke enhances the effects of radon, asbestos and formaldehyde (Zielinski).

Building materials and interior furnishings are major sources of hazardous office air pollution which include formaldehyde, asbestos and radon. These pollutants are emitted from very new, old or newly renovated buildings.

Formaldehyde is a pungent smelling gas found in common products like plastics, adhesives, wax-paper, and bonded wood products such as plywood, particleboard, panelling, flooring and furniture. The major source is urea formaldehyde foam insulation (UFFI) which was used extensively in walls of buildings since the 1970's. At low concentrations, formaldehyde can cause eye

and respiratory irritations, rashes, dizziness and nausea. Higher levels are known to cause nosebleeds, asthma, diarrhea, lung edema and pneumonia. Chronic exposures can cause nasopharyngeal cancer and can be teratogenic or mutagenic (Levin, Lester and Pordum).

Radon is a highly radioactive gas which is emitted from building materials made particularly from granite. Radon is most harmful when it is in a combination with other fine particles (eg. cigarette smoke) and is inhaled deeply into the lungs (Hilleman). The lung tissue may become irradiated and can lead to lung cancer and other respiratory infections.

Asbestos is a fibrous, flexible, incombustible and durable material commonly used for thermal insulation in buildings. Over 2,000 office and household products such as siding materials, filters, and cement, contain asbestos. It is easily dissipated into the air from cracks in the walls and pipes, and because it is so light, it remains airborne for a long period. The most common ailments are asbestosis which is a crippling lung disease, mesothelioma (a cancer of the abdominal cavity), and lung and gastro-intestinal cancer. Asbestos reacts synergistically with tobacco smoke as a co-carcinogen (Hilleman, American Lung Assoc.).

Aerosol products such as air fresheners, pesticide sprays, air cleaners, detergents and paints may emit a plethora of air pollutants which include toluene, benzene aldrin and volatile organics, most of which are carcinogenic.

Biological pollutants or microbes can be one of the most hazardous air pollutants which include a wide variety of virus, fungi, molds, pollen, bacteria and other pathogens. The warm, humid indoor environments provide a haven for the incubation and multiplication of these microbes. Microbes are incubated in plants, humidifiers, air conditioners, and toilets.

The most notorious example of microbial contamination is the Legionnaire's Disease in 1976 at a Philadelphia Legion's conference where over 200 people were hospitalized and 26 died from a new bacteria called Legionella. The virus was incubated in a malfunctioning air condition and humidifier system (Zielinski). This virus was responsible for more casualties at the Wadsworth Hospital in California (Boston Herald 2/3/87).

Computer video display terminals (VDT) comprise a new category of office air pollution. Over 20 million VDT's are now in use and the number is expected to grow to 100 million by the year 2000. Besides the complaints of glare, eye-strain, headache and stress from using VDT's, several studies reveal that heavy usage may lead to reproductive problems. The exposure to low level ionization radiation may be responsible for clusters of pregnancy problems and miscarriages among women. VDT's are also known to damage blood cells and can cause genetic damage (Canadian Center for Occupational Health and Safety Study 1983). It is recommended that a break should be taken every hour from VDT's and workers should limit their time to about four hours per day. Several protective screens are available on the market to reduce glare and radiation.

Office air is contaminated by a wide range of other sources. Underground garages are a major source of carbon monoxide and other hydrocarbons which can infiltrate to the other floors. Office building air exchange inlets may be wrongly located where traffic is heavy. Malfunctioning boilers can be a problem as in 1986 at the Westin Hotel in Boston where several people collapsed due to mild CO poisoning. Photocopiers are a major source of ozone and hydrocarbons.

Indoor air pollution in the office cannot be controlled in homes where a window can be opened. Office workers are, therefore, forced to breathe recycled contaminated air. The chronic effects of office air pollutants are still to be established and more scientific research is needed.

The overall effect may be critical to a large segment of the population susceptible to air pollutants which include asthmatics, people with other respiratory ailments, allergies, cardiac problems, mouth inhalers, pregnant women, the elderly and children. The overall effect of all these air pollutants, in combination with each other may have additive and synergistic health effects which is enhanced in the warm, humid office environment. The "Monday morning blues" may be a genuine physical reaction to indoor air pollution in the workplace.

## SOURCE CATEGORIES OF INDOOR AIR POLLUTANTS

### COMBUSTION BY-PRODUCTS

Gas and Kerosene Appliances
- CO, $NO_x$, TSP, $SO_2$, CO2.
- Hydrocarbons,
- Sulfates
- Nitrates

Wood-Burning
- CO, $NO_x$, TSP, $SO_2$
- Hydrocarbons
- Polycyclic Organic Compounds
- Benzo-a-pyrene
- Nitrates

Tobacco Smoking
- CO, TSP
- Benzo-a-pyrene
- Nicotene
- Nitrosamines
- Acrelein
- Polycyclic Organic Compounds
- Arsenic
- Aldehydes

### BUILDING MATERIALS

Formaldehyde
Radon
Asbestos
Alkanes
Aromatic Compounds
Hydrocarbons
Terpenes
Toluene
Benzene

### OTHER INDOOR SOURCES

Aerosols:
- Ammonium Sulphates
- Volatile Organic Compounds
- Toluene
- Vinyl Chloride

Pesticides and Detergents:
- Ammonium Sulphates
- Sodium Hydroxide
- Toluene
- Vinyl Chloride

Microbes:
- Spores, fungi, molds
- Allergens, bacteria
- House Dust Mites

Computer video display terminals (VDT)

### OUTOOR AIR POLLUTANTS

Sulphur Dioxide
Carbon Monoxide
Nitrogen Dioxide
Total Suspended Particulates
Ozone
Lead
Volatile Organic Compounds
Pollen

## FEDERAL AND STATE PROGRAMS

As the understanding of office air pollution and related health risks continue to grow slowly, so too are questions being raised as to the proper roles of federal and state agencies in addressing the problem. Scientific interest on the problem continues to grow but research on identifying sources and the health risks are still at an embryonic stage and has been described as haphazard and slow. Federal programs so far have been redundant, duplicative and contradictory and have led to conflicts, delays and inaction (Kirsch). The biggest conflict is that indoor and office air pollution is described as a 'grey' area and does not fall within any of the statutory mandates of the major federal agencies. (Berg).

A committee on Indoor Air Quality was set up by Congress in 1979 and met for the first time in 1983 to identify the level of programs among each federal agency. The lead role was designated to the EPA and the co-chairs include the Consumer Product Safety Commission (CPSC), Department of Energy (DOE), Dept. of Health and Human Services (HHS), Housing and Urban Development (HUD), Occupational Safety and Health Administration (OSHA), Dept. of Labor - Bureau of Standards and the Federal Trade Commission (Berg).

The EPA was granted $2 million in 1985 for indoor air pollution research. An Indoor Air Quality Act was introduced by Congress in 1987 to grant EPA $58m between 1988-'9 for developing a comprehensive national program for indoor air pollution control. The role of the EPA would be to coordinate other federal agencies, direct research on pollutants, and provide health advisories to other federal, state and local agencies and private organizations (Consumer Federation).

Four of EPA's statutes may have a limited bearing in addressing office air pollution: the Clean Air Act, Toxic Substances Control Act (TSCA), Federal Insecticide, Fungicide and Rodenticide Act, (FIFRA) and Uranium Mill tailings Radiation Act. EPA's statutory Authority to regulate air pollution is vested in the Clean Air Act. However, this act is construed to regulate outdoor or ambient air only and that EPA has no legal authority to regulate indoor air. Hence, no air quality standards have been set for indoor air pollutants such as radon, asbestos, formaldehyde and microbes (Repace). TSCA gives EPA authority to regulate toxic substances and can limit the manufacture of toxic chemicals or it can require specific labelling. Before any action is taken, a cost-benefit analysis is to be performed and this could be problematic in that the health impacts may be difficult to quantify.

The CPSC is authorized to regulate manufactured products and those that emit pollutants can be banned or returned to the manufacturer. Even though CPSC's authority is limited to consumer products, cigarettes are excluded (Kirsch). The CPSC proposed a national ban on UFFI but was overturned in court (Zielinski).

It is the DOE's recent emphasis on energy conservation which resulted in airtight buildings. DOE, together with the American Society of Heating, Refrigeration and Air Condition Engineers (ASHRAE) have developed ventilation standards, but this would be partially effective in reducing office air pollution because building codes apply to new construction (Repace).

OSHA and NIOSH regulate air pollution in the workplace but authority is confined to biohazards in the industrial workplace. Indoor air quality standards are set for the industrial workplace but not for the office. These standards are much higher than the ambient standards under EPA's Clean Air Act and are woefully inadequate for the office environment.

Because the federal indoor air quality program is still at a developmental stage, several states and localities are taking the initiative to institute control programs of their own. California has proposed a formaldehyde standard of .05ppm (EPRI).

Indoor air quality policies and programs in Massachusetts are fragmentary and scattered among various agencies, similar to the situation at the federal level. Currently, there are programs in the DEQE, DPH and the Dept. of Labor and Industries (DLI), which address certain aspects of radon, asbestos and formaldehyde. DEQE's Division of Air Quality has no jurisdiction to regulate office buildings and can control air pollutants when the source occurs outdoors. The DLI (which represents OSHA) handles workers' complaints and routinely checks for chemical exposure sources and testing for formaldehyde and carbon monoxide. The DPH responds to complaints from residents and performs routine checks on CO, $CO_2$ levels and ventilation rates. The DPH in 1979, banned UFFI use in the state but this ban was successfully challenged in court in 1983. (448 NERP.367). A 1987 statute restricts smoking in restaurants with seating of over 75 to have a designated non-smoking section (Zielinski). Indoor smoking is banned in public areas including courthouses, schools, colleges, museums, libraries and trains.

The control of air pollution in offices raises complicated policy questions about the role of the federal and state agencies. The complication arises from so many agencies involved such that no comprehensive office indoor air quality control program can be implemented by any one agency. This has resulted in partial, fragmentary, duplicative and contradictory programs at both the federal and state level (Sexton). More attention should be paid to identifying and resolving policy issues for developing a comprehensive office indoor policy.

## CONTROL STRATEGIES

Since a large proportion of the population is affected by office air pollution, the first strategy is to develop an educational or public outreach system to make office workers aware of the dangers of air pollution. The lead agencies, EPA and OSHA, should be responsible for this public outreach program. These two agencies should set office air quality standards the same way that standards are set for ambient air and the industrial working environment. Public awareness programs should be developed so as to give a better understanding of the available technology and strategies for controlling office air pollution. Office managers should be aware of these strategies which include source reduction, ventilation measures and air cleaning devices.

Source reduction of office air pollution involves the removal of the source or it can be inhibited by having a protective device. Personal behaviour can be modified as in the case of smoking, and should not be permitted within office buildings. Formaldehyde and asbestos in building materials if not entirely removed, should be properly sealed with plastic and duct tapes, coating of paints, lacquers, varnishes, and vinyl papers (EPRI).

The replacing of polluted office air with fresh outdoor air is the simplest method of reducing the problem. Natural ventilation involves the opening of doors and windows but this would add to energy costs in office buildings. Spot ventilation is effective if the source could be located, for example, an exhaust fan used in a washroom or smoking room. Mechanical ventilation include air-to-air heat exchangers to reduce heat loss and should not be placed near parking garages or heavy traffic.

There is a wide range of air cleaning devices which include filtration, electrostatic precipitation, ionization, absorption and adsorption (EPRI).

Air cleaning devices using filtration, precipitation and ionization are excellent for reducing air pollutants such as particulates, but cannot absorb gases like radon, or formaldehyde. Adsorbtion processes are best for reducing gases and are made from porous solids such as activated carbon, charcoal, alumina and silica gel. All these air cleaning devices when used in combination would help to reduce the major office air pollutants.

Office managers and building superintendents should be given special training in knowing the sources and health symptoms of office air pollutants, what appropriate federal, state or private agencies to contact if there is a serious problem, and what devices to be used for controlling the problem.

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